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Original article

Impact of hypoalbuminemia, frailty, and body mass index on early prognosis in older patients (≥85 years) with ST-elevation myocardial infarction

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ABSTRACT

Background: The optimal treatment strategies for acute ST-elevation myocardial infarction (STEMI) in older patients are unclear because of the high risk of mortality in this population. Hypoalbuminemia, frailty, and body mass index (BMI) have been reported to worsen the prognosis of some older patients with cardiovascular disease, but the specific impact of these factors on the prognosis after STEMI is poorly understood. The aim of this study was to investigate the impact of these factors on early outcomes in patients aged ≥85 years with acute STEMI.

Methods: Sixty-two consecutive eligible patients aged ≥85 years (mean age, 88.1 ± 2.5 years; age range, 85–94 years; female, 41.9%; primary percutaneous coronary intervention, 67.7%) who were admitted to our hospital with STEMI were retrospectively reviewed. Baseline patient characteristics, echocardiographic, electrocardiographic, and laboratory findings, and the Canadian Study of Health and Aging Clinical Frailty Scale (CSHA-CFS) score were assessed. The primary endpoint was in-hospital mortality and the secondary endpoint was failure of discharge to home. Independent baseline variables with a p-value of <0.15 in the univariate analyses were included in the multivariate analyses.

Results: Multivariate analysis identified a higher baseline serum troponin I level [$p = 0.046$; odds ratio (OR): 1.02], lower baseline albumin level ($p = 0.035$, OR: 0.16), and CSHA-CFS score ≥6 ($p = 0.028$, OR: 6.38) as independent predictors of in-hospital mortality. Lower BMI ($p < 0.001$, OR: 0.49) and CSHA-CFS frailty score ≥6 ($p = 0.002$, OR: 16.69) were identified as independent predictors of failure of discharge to home.

Conclusions: These findings indicate that the serum albumin level, CSHA-CFS score, and BMI, in addition to serum troponin I level, have an impact on the early prognosis of older patients with STEMI.

Introduction

The optimal treatment strategies for acute ST-elevation myocardial infarction (STEMI) in older patients are controversial as this population is growing and carries a high risk of mortality [1–4]. The factors known to affect outcomes after STEMI in the general population include cardiogenic shock, unprotected left main coronary artery occlusion, and suboptimal Thrombolysis In Myocardial Infarction (TIMI) flow grades after percutaneous coronary intervention (PCI) [5–7]. However, there is still insufficient evidence regarding the factors affecting outcomes after STEMI in older patients, as this population was not included in most of the important pivotal randomized clinical trials [8–10]. This lack of evidence can result in underestimation of the risks associated with procedures that may not confer a survival benefit in a particular patient cohort.

This study investigated the impact of baseline hypoalbuminemia, body mass index (BMI), and frailty on early prognosis after acute STEMI in patients aged ≥85 years. These factors appear to be particularly important in determining outcomes in older patients with cardiovascular disease, and better understanding of the roles of these factors may help to predict outcomes and potentially to make decisions about management strategy. Frailty is a complex clinical syndrome of increased vulnerability to stressors [11], and

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is associated with adverse long-term outcomes after PCI [12]. However, the impact of frailty on outcomes after STEMI is unclear. BMI is one of the factors used to calculate the Geriatric Nutritional Risk Index [13]. Although the impact of BMI on mortality after STEMI has been studied [14], the specific impact of BMI on outcomes in older patients is not well understood. Hypoalbuminemia, which predominantly results from malnutrition, inflammation, or cachexia, is common in patients with heart failure and increases in prevalence with age and illness [15,16]. One study found that hypoalbuminemia was associated with adverse outcomes, but not with mortality in patients with acute coronary syndrome [17]. However, the impact of hypoalbuminemia on outcomes after STEMI has not been well investigated. Older patients may be particularly vulnerable to hemodynamic changes, and we speculated that hypoalbuminemia, frailty, and BMI may have serious adverse effects in older patients with STEMI. The aim of this study was to investigate the impact of these factors on early outcomes in patients aged ≥85 years with acute STEMI.

Methods

Study design and population

The medical records of 65 consecutive patients aged ≥85 years who were admitted to the Saitama Medical University International Medical Center with acute STEMI between April 2007 and July 2014 were retrospectively reviewed. STEMI was defined as: (1) clinical evidence of ischemia, (2) echocardiogram showing new ST elevation at the J-point in two contiguous leads, with a cut-off point of ≥0.2 mV in men and ≥0.15 mV in women in leads V2–V3 or ≥0.1 mV in the other leads, and (3) at least one high myocardial biomarker level, defined as a serum troponin I or creatine kinase level above the 99th percentile of the normal reference population during the first 24 h after admission [18,19]. Patients who were not assessed for frailty ($n = 3$) were excluded, and the remaining 62 patients were included in the analyses.

Data collection

Baseline patient characteristics including age, sex, BMI, systolic and diastolic blood pressure, and heart rate were recorded. Hypertension was defined as current or previous treatment with antihypertensive medication. Diabetes mellitus was defined as current or previous treatment with antidiabetic medication (insulin or oral hypoglycemic drugs) or a hemoglobin A1c level of ≥6.5% (National Glycohemoglobin Standardization Program) [20]. Dyslipidemia was defined as current or previous treatment with anti-dyslipidemic medication. Previous end-stage renal disease requiring hemodialysis, myocardial infarction, congestive heart failure, stroke, PCI, coronary artery bypass grafting, valve surgery, and artificial pacemaker implantation were recorded based on interviews with the patients and/or their relatives. The initial symptoms suggestive of myocardial ischemia and the time from onset to arrival were recorded. The laboratory findings recorded included the baseline white blood cell count, hemoglobin concentration, and serum levels of troponin I, creatine kinase, creatine kinase MB isoenzyme, and albumin. The echocardiographic findings recorded included the left ventricular ejection fraction calculated by the Teichholz method and any significant valve disease. The electrocardiographic findings recorded included atrial fibrillation and ST segment changes; the number of leads with ST segment elevation, the maximum amplitude of ST segment elevation and the presumed location of infarct area were described (see echocardiographic criteria in the Supplementary Method). The Killip classification was determined based on the physical examination findings and the systolic blood pressure. Frailty was assessed using the Canadian Study of Health and Aging Clinical Frailty Scale (CSHA-CFS) score [21], and was classified as <6 or ≥6. A CSHA-CFS score of ≥6 indicates that help is needed with both instrumental and non-instrumental activities of daily living.

Outcomes

The primary endpoint was in-hospital death. The secondary endpoint was failure of discharge to home. Failure of discharge to home was defined as the composite of in-hospital mortality and new transfer to a hospital/nursing home (transfer to a hospital/nursing home was only considered to be failure of discharge to home if the patient was not in a hospital/nursing home immediately prior to admission).

Treatment protocol

On admission, patients underwent a quick evaluation that included taking a history and performing a physical examination, electrocardiogram, chest X-ray, echocardiogram, and blood tests. The attending physician then decided whether to manage the patient with primary PCI or conservative therapy (see detail in Supplementary Method). Written informed consent was obtained from each patient and/or the patient's relatives before PCI. None of the patients received systemic thrombolytic therapy.

Other therapeutic interventions were performed at the discretion of the attending physician, including blood transfusion for anemia, mechanical ventilation for respiratory failure or shock, administration of diuretics for congestive heart failure, and administration of inotropes for hypotension or hypoperfusion.

Statistical analysis

Continuous variables are expressed as mean ± standard deviation or median (first to third quartile) and categorical variables as number (%). Categorical variables between the groups were compared using the χ^2 test or Fisher's exact probability test. Univariate and multivariate logistic regression analyses were performed to identify the independent predictors of in-hospital mortality and failure of discharge to home. Independent baseline variables with a p-value of <0.15 in the univariate analyses were included in the multivariate analyses.

A p-value of <0.05 was considered to be statistically significant. All statistical analyses were performed using JMP V.10.0.0 (SAS Institute, Inc., Cary, NC, USA).

Ethics approval

The study was conducted according to the guideline of the Declaration of Helsinki and was approved by the Institutional Review Board of the International Medical Center of Saitama Medical University (reference number 14028), who waived the need for patient consent for inclusion.

Results

Patient characteristics

The baseline clinical characteristics of all 62 patients and the results of univariate regression analyses for in-hospital mortality are shown in Table 1. The mean age of the patients was 88.1 ± 2.5 years (range, 85–94 years) and 41.9% were female. Forty-three patients (69.4%) had hypertension, 10 (16.1%) had diabetes mellitus, and 14 (22.6%) had dyslipidemia. The median time from onset to arrival was 6 h (first-third quartile: 3–12 h). The initial symptoms suggestive of myocardial ischemia were: chest

Table 1
Univariate analyses of associations between baseline variables and in-hospital mortality.

	Total (n = 62)	p univariate	OR	95% CI
Demographics				
Age, years	88.1 ± 2.5	0.610	0.94	0.71–1.19
Female, n (%)	26 (41.9)	0.937	1.05	0.30–3.49
BMI, kg/m^2	21.0 ± 3.3	0.107	0.82	0.63–1.02
Coexisting conditions, n (%)				
Hypertension, n (%)	43 (69.4)	0.848	1.14	0.32–4.67
Diabetes mellitus, n (%)	10 (16.1)	0.829	0.83	0.12–3.91
Dyslipidemia, n (%)	14 (22.6)	0.381	0.50	0.07–2.19
ESRD on HD, n (%)	5 (8.1)	0.361	2.50	0.3–16.8
Previous MI, n (%)	7 (11.3)	0.600	0.54	0.03–3.57
Previous CHF, n (%)	14 (22.6)	0.198	2.41	0.62–8.91
Previous stroke, n (%)	10 (16.1)	0.829	0.82	0.12–3.91
Previous PCI, n (%)	7 (11.3)	0.560	0.54	0.03–3.57
Previous CABG, n (%)	2 (3.2)	0.388	3.62	0.14–95.65
Previous valve surgery, n (%)	0 (0.0)	N/A	N/A	N/A
Previous PMI, n (%)	2 (3.2)	0.388	3.62	0.14–95.65
Findings at presentation				
Time from onset to arrival, h	6 (3–12)	0.338	0.98	0.97–1.08
Systolic BP, mmHg	130.1 ± 32.4	0.252	0.99	0.97–1.01
Diastolic BP, mmHg	71.0 ± 21.0	0.881	1.00	0.97–1.03
Heart rate, bpm	79.9 ± 24.7	0.587	1.01	0.98–1.03
WBC count, $\times 10^3$/mm^3	9.9 ± 3.5	0.130	1.14	0.96–1.36
Hemoglobin, g/dl	12.4 ± 2.2	0.150	0.81	0.60–1.07
Troponin I, ng/ml	4.6 (0.4–25.1)	0.060	1.02	1.00–1.04
Creatinine, mg/dl	1.0 (0.8–1.5)	0.468	1.42	1.02–2.12
Creatine kinase, IU/I	246 (129–667)	0.309	1.00	1.00–1.00
Creatine kinase MB, IU/l	15 (5–42)	0.216	1.00	1.00–1.01
Albumin, g/dl	3.59 ± 0.50	0.008*	0.16	0.03–0.57
LVEF, %	56.8 ± 15.0	0.159	0.97	0.93–1.01
Valvular disease, n (%)	4 (6.5)	0.213	3.83	0.43–34.75
Atrial fibrillation, n (%)	13 (21.0)	0.439	1.73	0.40–6.61
Number of leads with ST elevation, n	3 (2–5)	0.762	0.94	0.04–7.86
Maximum amplitude of ST elevation, mV	0.28 (0.15–0.36)	0.768	1.76	0.03–69.74
Killip class ≥III, n (%)	16 (25.8)	0.110	2.85	0.78–10.24
CSHA-CFS score ≥6, n (%)	22 (35.5)	0.059	3.24	0.96–11.55
Therapeutic intervention				
Primary PCI	42 (67.7)	0.027*	0.07	0.07–0.86
Mechanical ventilation, n (%)	9 (14.5)	0.044*	4.37	1.05–18.35
Inotropes, n (%)	18 (29.0)	<0.001*	21.48	5.28–115.18
Diuretics, n (%)	28 (45.2)	0.844	0.89	0.26–2.94
Blood transfusion, n (%)	4 (6.5)	<0.001*	62.67	9.34–1274.78
Clinical outcomes				
In-hospital death, n (%)	14 (22.6)	–	–	–
Transfer to hospital/nursing home, n (%)	8 (12.9)	–	–	–
Failure of discharge to home, n (%)	22 (35.5)	–	–	–

Continuous variables are expressed as mean ± standard deviation or median (first-third quartile) and categorical variables as number (%).
Univariate logistic regression analyses.
OR, odds ratio; CI, confidence interval; BMI, body mass index; ESRD, end-stage renal disease; HD, hemodialysis; CHF, congestive heart failure; PCI, percutaneous coronary intervention; CABG, coronary artery bypass grafting; PMI, pacemaker implantation; BP, blood pressure; WBC, white blood cell; LVEF, left ventricular ejection fraction; CSHA-CFS, Canadian Study of Health and Aging Clinical Frailty Scale; N/A, not analyzed.
* $p < 0.05$.

pain/discomfort (n = 38), nausea/vomiting (n = 14), dyspnea (n = 6), and altered/loss of consciousness (n = 4). The median number of leads with ST segment elevation was 3 and the maximum amplitude of ST segment elevation was 0.28 mV (Table 1). The presumed locations of infarcted area were: the anterior wall (n = 25), the inferior wall (n = 24), the posterior/lateral wall (n = 12), and the global wall (n = 1). Sixteen patients (25.8%) were classified as Killip class III or IV, and 35.5% has a CSHA-CFS score of ≥6. Hypoalbuminemia was the only baseline independent variable significantly associated with in-hospital mortality on univariate analysis.

Primary PCI was performed in 42 patients (67.7%), and receiving conservative therapy only was associated with in-hospital mortality. Mechanical ventilation (required in 14.5% of patients), inotropic support (required in 29.0% of patients), and blood transfusion (required in 6.5% of patients) were also associated with in-hospital mortality. There were 14 in-hospital deaths, which were due to ventricular rupture (n = 3), low output and pulmonary edema (n = 6), bradycardia (n = 1), ventricular fibrillation (n = 2), cerebral infarction (n = 1), and possible infection (n = 1). Twenty-two patients (35.5%) failed to discharge to home.

In the subgroup that underwent primary PCI (n = 42, Supplementary Table 1), multi-vessel disease including left main disease was found in 27 patients (64.3%). The infarct-related artery was the left main trunk to proximal left anterior descending artery in four patients (9.5%), none of whom died during hospitalization. Stent implantation was performed in 35 patients (83.3%), and coronary interventions other than stent implantation (balloon dilatation or thrombus aspiration only) were associated with in-hospital mortality. TIMI flow grade ≤II after PCI (n = 8, 19.0%) and use of intra-aortic balloon pumping (n = 10, 23.8%) were associated with in-hospital mortality.

Primary PCI was performed less frequently in patients with a CHSA-CFS score of ≥6 (50.0% *versus* 77.5%, p = 0.046, Supplementary Fig. 1A). In patients with a CHSA-CFS score of ≥6, performing primary PCI may be related to lower in-hospital mortality, although not significantly (18.8% *versus* 54.6%, p = 0.183, Supplementary

Table 2
Multivariate analyses for prediction of in-hospital death and failure of discharge to home.

	In-hospital mortality			Failure of discharge to home		
	p	OR	95% CI	*p*	OR	95% CI
Female	–	–	–	0.184	2.95	0.60–16.53
BMI	0.782	0.96	0.68–1.28	<0.001*	0.49	0.26–0.76
WBC count	0.458	0.90	0.68–1.17	0.397	1.14	0.85–1.58
Hemoglobin	–	–	–	0.643	0.89	0.3–1.43
Troponin I	0.046*	1.02	1.00–1.06	0.362	1.02	0.99–1.06
Albumin	0.035*	0.16	0.02–0.88	0.181	0.22	0.22–1.57
Killip class ≥III	0.051	6.08	0.99–50.90	–	–	–
LVEF	–	–	–	0.587	0.26	0.02–1.85
CSHA-CFS score ≥6	0.028*	6.38	1.21–44.7	0.002*	16.69	2.67–175.02

Logistic regression analyses.
OR, odds ratio; CI, confidence interval; BMI, body mass index; WBC, white blood cell; LVEF, left ventricular ejection fraction; CSHA-CFS, Canadian Study of Health and Aging Clinical Frailty Scale.
* $p < 0.05$.

Fig. 1B). On the other hand, in patients with a CHSA-CFS score of <6, performing primary PCI may be related to a lower incidence of failure of discharge to home (12.9% *versus* 55.6%, $p = 0.159$, Supplementary Fig. 1C), although not significantly.

Logistic regression analyses for prediction of in-hospital mortality and failure of discharge to home

The median length of hospital stay was 15 days (8–23 days). Univariate analyses showed that lower BMI ($p = 0.107$), higher white blood cell count ($p = 0.130$), higher serum troponin I level ($p = 0.060$), lower serum albumin level ($p = 0.008$), Killip class ≥III ($p = 0.110$), and CSHA-CFS score ≥6 ($p = 0.059$) were significantly or marginally associated with in-hospital mortality ($p < 0.15$; Table 1). Multivariate analysis identified a higher serum troponin I level [$p = 0.046$, odds ratio (OR): 1.02] and lower serum albumin level ($p = 0.035$, OR: 0.16), and CSHA-CFS score ≥6 ($p = 0.028$, OR: 6.38) as independent predictors of in-hospital mortality (Table 2).

Univariate analysis showed that female sex ($p = 0.043$), lower BMI ($p = 0.002$), higher white blood cell count ($p = 0.100$), lower hemoglobin concentration ($p = 0.025$), higher serum troponin I level ($p = 0.362$), lower serum albumin level ($p = 0.002$), lower left ventricular ejection fraction ($p = 0.126$), and higher CSHA-CFS score ($p = 0.004$) were significantly or marginally associated with failure of discharge to home ($p < 0.15$, Supplementary Table 2). Multivariate analysis identified a lower BMI ($p < 0.001$, OR: 0.49) and CSHA-CFS score ≥6 ($p = 0.002$, OR: 16.69) as independent predictors of failure of discharge to home (Table 2).

Discussion

The treatment of older patients with STEMI is challenging because multiple factors that contribute to adverse outcomes must be considered, including both revascularization procedure-related events and non-cardiovascular events associated with aging. This study demonstrated that in patients with STEMI aged ≥85 years, (1) hypoalbuminemia, a CSHA-CFS score of ≥6, and a high serum troponin I level at presentation are independently associated with in-hospital mortality, and (2) a lower BMI and CSHA-CFS score of ≥6 are independently associated with failure of discharge to home.

Known predictors of poor outcomes in patients with STEMI

Because our cohort included patients who received primary PCI as well as patients who received conservative therapy only, our potential predictors of interest were the variables at the time of presentation, rather than procedure-related outcomes or therapeutic interventions during hospitalization. Our results show that the baseline serum troponin I level was independently associated with in-hospital mortality. The serum troponin I level is an established cardiac biomarker with high sensitivity and specificity for cardiac injury [18]. A single serum troponin I level measured at 4 h after reperfusion was well correlated with infarct size [22]. The serum troponin I level increases earlier than other cardiac biomarkers. In the present study, the baseline serum troponin I level was significantly associated with in-hospital mortality, suggesting that this parameter reflects late arrival after the onset. On the other hand, there were no significant associations between the time from onset to arrival and the clinical outcomes (Table 1, Supplementary Table 2). Considering the modest proportion of the patients with typical chest symptoms (61%), we speculate that the time from onset to arrival informed by the patients and/or their relatives were relatively unreliable in older patients. A high Killip class was not significantly associated with in-hospital mortality in the present study ($p = 0.051$), but this finding appears to be consistent with previous studies which showed the impact of Killip class on mortality [1,2,7,23].

The significant associations between in-hospital morality and advanced therapies such as mechanical ventilation, inotropic support, blood transfusion, or intra-aortic balloon pumping may be predominantly attributable to the severity of the illness of the patients who required these therapies, rather than a reflection of procedure-related complications.

In the subgroup of patients who underwent primary PCI, suboptimal TIMI flow after PCI was associated with in-hospital mortality on univariate analysis, which is also consistent with the findings of previous studies [1,5,6]. On the other hand, stent implantation was associated with a lower in-hospital mortality, possibly because patients with suboptimal TIMI flow after thrombus aspiration or balloon dilatation were less likely to undergo stent implantation.

Impact of hypoalbuminemia, BMI, and frailty on outcomes after STEMI

This is the first study to show that hypoalbuminemia, a CSHA-CFS score of ≥6, and lower BMI were independently associated with early prognosis in patients aged ≥85 years with acute STEMI. We consider that the roles of these factors to be especially important in older patients with cardiovascular disease. Hypoalbuminemia is an indicator of malnutrition, which may occur in various conditions and is independently associated with all-cause mortality in older people, especially in those with decreased physical disability [24,25]. Hypoalbuminemia has been reported to be associated with a poor prognosis in patients with heart failure, together with anemia and renal failure [15,26,27]. Our study also

showed that the lower hemoglobin concentration was associated with failure of discharge to home on univariate analysis. Hypoalbuminemia may result from hemodilution in fluid-overloaded patients [28] and may facilitate the development of pulmonary edema in patients with low colloid osmotic pressure [15]. We propose that older patients may be particularly vulnerable to adverse outcomes in association with hemodynamic changes, and that the adverse effects of hypoalbuminemia are therefore particularly important in our cohort.

Increased frailty is associated with a higher mortality rate in patients with coronary artery disease aged ≥70 years, in addition to the previously validated risk factors for mortality [29]. Our study demonstrated that increased frailty is an independent predictor of both in-hospital mortality and failure of discharge to home in older patients with STEMI. There are many methods of assessing frailty [30]. CHSA-CFS is a measure for assessing frailty based on physical function and level of independence with activities of daily living; the frailty is classified using a seven point rating scale (1: very fit, 2: well without active disease, 3: well with treated comorbid disease, 4: apparently vulnerable, 5: mildly frail, 6: moderately frail, and 7: severely frail) [30]. In this study we used the CSHA-CFS score because it has a simple, distinct demarcation line, with a score of ≥6 indicating that help is needed with both instrumental and non-instrumental activities of daily living, including activities such as eating or bathing.

The impact of BMI on mortality after STEMI has previously been studied. Patients with lower BMI demonstrated worse outcomes after STEMI; however, these patients were older and this finding may have been confounded by age [14,31,32]; generally, older patients included in clinical studies had lower BMI than younger patients. In the present study, BMI was significantly associated with failure of discharge to home after STEMI in patients with the limited range of age (85–94 years); this finding implies the importance of BMI itself in this cohort.

Failure of discharge to home is our novel dependent variable. Clinically, explanation of this outcome to patients or their relatives may be particularly important in this cohort because failure of discharge to home occurs more frequently in older patients than younger patients. The findings that frailty and lower BMI were associated with failure of discharge to home in older patients with STEMI may be useful in deciding on better in-hospital management (such as early rehabilitation or feeding) in order to reduce this outcome.

Relationship between therapeutic strategies, frailty and clinical outcomes

Performing PCI was reported to be associated with better outcomes in older patients with acute coronary syndrome [33]. In our study, primary PCI was performed less frequently in patients with a CHSA-CFS score of ≥6 (Supplementary Fig. 1A), presumably because physicians might have expected poor clinical outcomes in "apparently" frail patients despite maximal invasive therapy. In patients with a CHSA-CFS score of ≥6, performing PCI might have reduced in-hospital mortality (Supplementary Fig. 1B). On the other hand, in patients with a CHSA-CFS score of <6 (*i.e.* less frail patients), performing primary PCI might have reduced incidence of failure of discharge to home (Supplementary Fig. 1C). We speculated that performing primary PCI for less frail older patients might have facilitated early rehabilitation, resulting in early recoveries of patients' physical condition.

Limitations

This study has several limitations. First, it was a single-center study, with a relatively small number of patients. However, the baseline serum albumin level, CSHA-CFS score, and BMI were significant predictors of early prognosis despite the small number of patients. Second, many patients were lost to follow-up within 1 month, and mortality after discharge could not be analyzed. Survival analysis over a longer period may have yielded different findings. However, in older patients, who may die from a number of causes, longer-term analyses may obscure the direct impact of STEMI on mortality. Third, the retrospective nature of the study and the lack of a standardized treatment protocol in terms of deciding on primary PCI *versus* conservative treatment may have introduced bias into statistical analyses. We believe that the findings of this study can be used to plan further multi-center, prospective studies. Fourth, because our current study was aimed to determine the candidate predictors obtained before performing PCI, the impact of primary PCI on the clinical outcome was not clarified. Instead we stratified the patients into two groups according to their frailty (CHSA-CFS score of ≥6, or <6) to consider the roles of primary PCI. To clarify the role(s) of PCI, we should adjust the background characteristics of the patients who are assigned to either of the treatments using randomization, stratification, propensity score matching, all of which may require a larger number of patients. Finally, the association between hypoalbuminemia and fluid status was not evaluated by measurement of neurohormone levels (such as brain-natriuretic peptide) because these data were not available for a substantial proportion of patients. Neurohormone levels were therefore not included as independent variables in the analysis.

Conclusion

Hypoalbuminemia, a CSHA-CFS score of ≥6, and higher baseline serum troponin I level were significantly associated with in-hospital mortality in patients with STEMI aged ≥85 years. Lower BMI and a CSHA-CFS score of ≥6 were significantly associated with failure of discharge to home. These findings suggest that the serum albumin level, CSHA-CFS score, and BMI are associated with early outcomes in older patients with STEMI.

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Conflict of interest

None.

Authors' contribution

Y.S., J.T., S.N., S.F., and Y.H. conceptualized and designed the study. Analysis and interpretation of data were also done by them. Drafting the manuscript or revising it critically for important intellectual content was done by S.N. and T.K. Final approval of the manuscript submitted was given by S.N.

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This study was present at the 27th Annual Meeting of the Japanese Coronary Association.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at doi:10.1016/j.jjcc.2014.12.001.

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